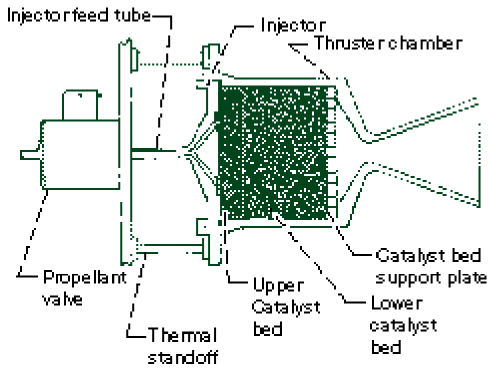
On-Board Chemical Propulsion

NASA Lewis Research Center's On-Board Propulsion program (OBP) is developing low-thrust chemical propulsion technologies for both satellite and vehicle reaction control applications. There is a vigorous international competition to develop new, high-performance bipropellant engines. High-leverage bipropellant systems are critical to both commercial competitiveness in the international communications market and to cost-effective mission design in government sectors. To significantly improve bipropellant engine performance, we must increase the thermal margin of the chamber materials. Iridium-coated rhenium (Ir/Re) engines, developed and demonstrated under OBP programs, can operate at temperatures well above the constraints of state-of-practice systems, providing a sufficient margin to maximize performance with the hypergolic propellants used in most satellite propulsion systems.

For the near term, the OBP program is focused on transferring Ir/Re technology to the user community. This effort includes the development of low-cost fabrication and joining technologies, the generation of Re mechanical properties, and critical technology demonstrations. Lightweight, low-volume, high-pressure bipropellant engine technology is also being developed for small-satellite applications requiring high thrust. This effort targets 200- to 500-kg satellites to be launched on inexpensive, volume-limited launch vehicles.

For the long term, the OBP program is developing chamber materials for long-life operation in combustion environments that are more energetic and oxidizing than hypergolic propellants. The long-range goal is to develop a material system that can run any propellant combination at any mixture ratio.

In addition to the bipropellant efforts, OBP is also developing high-performance, nontoxic, monopropellant systems to replace state-of-practice hydrazine (N_2H_4) monopropellant thrusters. The monopropellants under consideration are based on liquid gun-propellant formulations, which are environmentally friendly, have a high density, and have better thermal characteristics than hydrazine. The near-term goal is to transfer a "green" system to improve mission performance and greatly reduce ground operations costs. For the far-term, a very high performance (high specific impulse) system is being sought. The key to this goal is the development of a high-temperature catalyst; research in this area is underway.



Advanced monopropellant thruster.

For very small spacecraft and microspacecraft, several chemical propulsion technologies that provide performance and system benefits are being explored. Examples include (1) a warm gas propulsion system that uses a mixture of hydrogen, oxygen, and an inert gas (nitrogen or helium) and that offers a high specific impulse alternative to state-of-practice cold gas systems with a minimal increase in complexity; (2) exothermic decomposing solid and hybrid systems, which offer the high density and simplicity of solid propellants for low-thrust, quick-response applications; (3) a water electrolysis concept that can provide dual use as a combined propulsion/power system; and (4) a microturbomachinery-based bipropellant system for very high-performance applications which uses microelectronic mechanical system (MEMS) fabrication technology to provide propulsion systems "on-a-chip" similar to computer chips.

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